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Claims

[c1] 1.An apparatus for distributing a fluid in a gas flow path inside a turbomachine, comprising:
a device for introducing the fluid into the gas flow path; and
wherein the device is positioned within the gas flow path.

[c2] 2.The apparatus of claim 1, wherein the atomized fluid enters the gas flow path at a low pressure surface proximal to a stator blade.

[c3] 3.The apparatus of claim 1, wherein the fluid is distributed radially.

[c4] 4.The apparatus of claim 1, wherein the turbomachine is a compressor.

[c5] 5.The apparatus of claim 1, wherein the turbomachine is a gas turbine.

[c6] 6.The apparatus of claim 1, wherein the device is a stator blade.

[c7] 7.The apparatus of claim 1, wherein the device is a rotor blade.

[c8] 8.The apparatus of claim 1 wherein the device is a tube placed in the wake of a stator blade.

[c9] 9.The apparatus of claim 1 wherein the atomized fluid enters the gas flow path at a high pressure surface proximal to a stator blade.

[c10] 10.An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
at least one stator blade in at least one turbomachine stage;
a fluid channel in fluid communication with an interior of the stator blade;
a fluid supply in fluid communication with the fluid channel; and
at least one orifice located at an orifice surface of the stator blade, the orifice in fluid communication with the interior of the stator blade.

[c11] 11.The apparatus of claim 10, wherein the orifice surface is located at a low pressure surface of the stator blade.

[c12] 12.The apparatus of claim 10, wherein the orifice surface is located at a high pressure surface of the stator blade.

[c13] 13.The apparatus of claim 10 further comprising:
at least one air foil located proximate to the at least one

orifice, and configured to direct flowing gas towards fluid exiting the at least one orifice.

[c14] 14.The apparatus of claim 13, wherein the at least one air foil is a single bi-flow air foil structure.

[c15] 15.The apparatus of claim 10, wherein every stator blades in the at least one turbomachine stage is configured in the same manner as the at least one stator blade.

[c16] 16.An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
at least one stator blade in at least one turbomachine stage;
a gas channel;
a fluid channel located at an interior of the stator blade, and configured to form a porous annulus around the gas channel to allow fluid from the fluid channel to pass into the gas channel;
a fluid supply in fluid communication with the fluid channel; and
at least one orifice located at an orifice surface of the stator blade, the orifice in fluid communication with the gas channel.

[c17] 17.The apparatus of claim 16, wherein the gas channel is supplied with gas from an external source.

[c18] 18.The apparatus of claim 16, wherein the gas channel has an opening located at a max pressure surface of the stator blade.

[c19] 19.The apparatus of claim 16, wherein the opening is located at the leading edge of the stator blade.

[c20] 20.The apparatus of claim 16, wherein the orifice is located at a low pressure surface of the stator blade.

[c21] 21.The apparatus of claim 16 wherein the porous annulus comprises a steel tube with more than about 20 holes of greater than about 10 microns in diameter.

[c22] 22.The apparatus of claim 16 wherein the porous annulus comprises a steel tube with less than about 50 holes of smaller than about 100 microns in diameter.

[c23] 23. The apparatus of claim 16 wherein the porous annulus comprises sintered stainless steel tube.

[c24] 24.The apparatus of claim 16 wherein the porous annulus comprises a tube formed from a steel mesh with a porosity of greater than about 0.016%.

[c25] 25.The apparatus of claim 16 wherein the porous annulus comprises a tube formed from a steel mesh with a porosity of less than about 0.4%.

[c26] 26.The apparatus of claim 16, wherein the fluid channel is configured to accept pressurized fluid from an external source.

[c27] 27. An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
at least one stator blade in at least one turbomachine stage, the stator blade comprising a porous material throughout its in interior, and the porous material is exposed on a portion the stator blade's max pressure surface and a portion of the stator blade's orifice surface;
a fluid channel located at the interior of the stator blade, and configured to provide fluid to the interior the stator blade;
a fluid supply in fluid communication with the fluid channel; and
wherein the stator blade is configured to admit gas from the gas flow path of the turbomachine via the max pressure surface and mix with fluid provided by the fluid channel, and the atomized fluid exits the stator blade through the orifice surface.

[c28] 28.The apparatus of claim 27, wherein the max pressure surface is on the leading edge of the stator blade.

[c29] 29.The apparatus of claim 27, wherein the orifice surface

is on the low pressure surface of the stator blade.

[c30] 30.The apparatus of claim 27 wherein the porous material is a sintered stainless steel.

[c31] 31.The apparatus of claim 30, wherein the sintered stainless steel has a porosity of greater than about 0.016%.

[c32] 32.The apparatus of claim 30, wherein the sintered stainless steel has a porosity of less than about 0.4%.

[c33] 33.An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
at least one stator blade in at least one turbomachine stage, the stator blade comprising a cavity throughout a portion of its interior and a porous material on a portion of its orifice surface;
a fluid channel located at the interior of the stator blade, and configured to provide fluid to the interior the stator blade;
a fluid supply in fluid communication with the fluid channel; and
wherein the stator blade is configured to accept fluid into its interior from the fluid channel, and allows the fluid to flow from the interior through the porous material of the orifice surface and enter the gas flow path of

the turbomachine.

[c34] 34.The apparatus of claim 33, wherein the orifice surface is on a low pressure surface of the stator blade.

[c35] 35.The apparatus of claim 33 wherein the porous material is a sintered stainless steel.

[c36] 36.The apparatus of claim 34, wherein the sintered stainless steel has a porosity greater than about 0.016%.

[c37] 37.The apparatus of claim 34, wherein the sintered stainless steel has a porosity less than about 0.016%.

[c38] 38.An apparatus for distributing an atomized fluid in a gas flow path inside a turbomachine, the apparatus comprising:
a heat exchanger configured to heat a fluid from an external source;
at least one stator blade in at least one turbomachine stage, the stator blade comprising a cavity throughout a portion of its interior;
at least one atomizer located at an orifice surface of the stator blade, the atomizer communicatively coupled the cavity; and
wherein the stator blade is communicably coupled to the heat exchanger to accept heated fluid into the cavity whereupon the heated fluid exits the cavity through the

atomizer orifice and enters the gas flow path of the turbomachine.

[c39] 39.The apparatus of claim 38, wherein the orifice surface is on a low pressure surface of the stator blade.

[c40] 40.The apparatus of claim 38, wherein the heat exchanger is further configured to use gas from the turbomachine to heat the fluid.

[c41] 41.The apparatus of claim 40, wherein the heat exchanger is further configured to use the fluid to cool the gas from the turbomachine.

[c42] 42.The apparatus of claim 41, wherein the stator blade is communicably coupled to the heat exchanger to accept heated fluid and cooled gas into the cavity such that the cooled gas assists in atomizing the heated fluid, prior to the heated fluid exiting the cavity through the orifice and entering the gas flow path of the turbomachine.

[c43] 43.The apparatus of claim 40, wherein the gas is from a late stage area of the turbomachine.

[c44] 44.The apparatus of claim 38, wherein the stator blade is located at a mid stage of the turbomachine.

[c45] 45.The apparatus of claim 38, wherein the stator blade is located at an early stage of the turbomachine.

[c46] 46.The apparatus of claim 38, wherein every stator blade in the at least one turbomachine stage is configured in the same manner as the at least one stator blade.

[c47] 47.An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
a heat exchanger configured to heat a fluid from an external source;
at least one stator blade in at least one turbomachine stage;
a tube located proximate to an orifice surface of the stator blade;
at least one orifice located on a side of the tube, and the orifice communicatively coupled the cavity; and
wherein the tube is communicably coupled to the heat exchanger to accept heated fluid into the cavity whereupon the heated fluid exits the cavity through the orifice and enters the gas flow path of the turbomachine.

[c48] 48. An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
at least one stator blade in at least one turbomachine stage, the stator blade comprising at least one chamber;
the chamber comprising a vibration plate that is operatively coupled to a vibration generator;
a fluid channel located at the interior of the stator blade,

and communicably coupled to the chamber;

at least one orifice in fluid communication with the chamber, and located at an orifice surface of the stator blade;

a fluid supply in fluid communication with the fluid channel; and

wherein the chamber is configured to provide a pulsation to a fluid supplied to the chamber via the fluid channel, prior to the fluid exiting the chamber through the orifice to enter the gas flow path of the turbomachine.

[c49] 49.The apparatus of claim 48, wherein the chamber is configured to accept pressurized fluid from the fluid channel.

[c50] 50.The apparatus of claim 49 wherein the fluid is pressurized to about 30 psia.

[c51] 51.The apparatus of claim 48, wherein the pulsation frequency is greater than about 1 MHZ.

[c52] 52.The apparatus of claim 48, wherein the pulsation frequency is less than about 10 MHZ.

[c53] 53.The apparatus of claim 48, wherein the vibration generator is a piezoelectric actuator.

[c54] 54.The apparatus of claim 48, wherein the vibration

generator is a bi-metallic strip.

[c55] 55.The apparatus of claim 48, wherein the vibration generator is a capacitor.

[c56] 56.The apparatus of claim 48, wherein every stator blade in the at least one turbomachine stage is configured in the same manner as the at least one stator blade.

[c57] 57.An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
at least one stage of a turbomachine, the stage comprising a 360 degree casing and at least one stator blade extending radially from an inner surface of the casing;
a casing groove located at the inner surface of the casing;
a stator blade cavity located at an interior of the stator blade, and in fluid communication with the casing groove;
a port located at the casing and in fluid communication with the casing groove; and
at least one orifice located at an orifice surface of the stator blade, the orifice in fluid communication with the stator blade cavity.

[c58] 58.The apparatus of claim 57, wherein the casing groove extends for the entire 360 degrees of the inner surface

of the casing.

[c59] 59.The apparatus of claim 57, wherein the orifice surface is at a low pressure surface of the stator blade.

[c60] 60.The apparatus of claim 57, wherein the interface between the at least one stator blade and the casing is sealed with a static seal.

[c61] 61.The apparatus of claim 60, wherein the static seal is a rope seal.

[c62] 62.The apparatus of claim 57, wherein the casing groove between adjacent stator blades are seal with a static seal.

[c63] 63.The apparatus of claim 62, wherein the static seal is a rope seal.

[c64] 64.The apparatus of claim 57 further comprising a stator blade groove located at a top surface of the stator blade, the stator blade groove and casing groove forming a larger plenum cavity between the stator blade and the casing.

[c65] 65.The apparatus of claim 64, wherein every stator blade in the at least one turbomachine stage is configured in the same manner as the at least one stator blade.

[c66] 66.An apparatus for distributing an atomized fluid in a

gas flow path inside a turbomachine, the apparatus comprising:

at least one stage of a turbomachine, the stage comprising a 360 degree casing and at least one stator blade extending radially from an inner surface of the casing;

a casing groove located at the inner surface of the casing;

a stator blade cavity located at an interior of the stator blade, and in fluid communication with the casing groove;

a port located at the casing and in fluid communication with the casing groove; and

at least one atomizer with at least one orifice located at an orifice surface of the stator blade, the orifice in fluid communication with the stator blade cavity.

[c67] 67.A method for installing an apparatus that will distribute a fluid in a gas flow path inside a turbomachine, the method comprising:

machining a casing groove along an inner surface of a casing;

machining at least one port into the casing that is in fluid communication with the casing groove;

machining an internal cavity in at least one stator blade that is in fluid communication with the casing groove;

machining at least one orifice, that is in fluid communi-

cation with the internal cavity, on an orifice surface of the stator blade; and
coupling a fluid supply to the at least one port.

[c68] 68.The method of claim 67, wherein the casing groove is machined along a 360 degree circumference of the inner surface of the casing.

[c69] 69.The method of claim 67, wherein the orifice surface is on a low pressure surface of the stator blade.

[c70] 70.The method of claim 67, further comprising machining a stator blade groove on a top surface of the at least one stator blade;
71.The method of claim 68, further comprising:
machining a stator blade groove on a top surface of every stator blade in at least one turbomachine stage.

[c71] machining at least one orifice, that is in fluid communication with the internal cavity, on an orifice surface of every stator blade in the turbomachine stage.

[c72] 72.The method of claim 69, further comprising:
machining an internal cavity in every stator blade in the turbomachine stage, where each cavity is in fluid communication with each stator blade groove;
machining at least one orifice, that is in fluid communication with the internal cavity, on an orifice surface of

every stator blade in the turbomachine stage.

[c73] 73.An apparatus for distributing a fluid in a gas flow path inside a turbomachine, the apparatus comprising:
at least one stator blade in at least one turbomachine stage;
a tube located proximate to an orifice surface of the stator blade;
at least one orifice located on a side of the tube; and
a fluid supply in fluid communication with the bayonet-like tube.

[c74] 74.The apparatus of claim 73, wherein the orifice surface is on a low pressure surface of the tube.

[c75] 75.The apparatus of claim 73, wherein the tube follows a contour of the stator blade low pressure surface.

[c76] 76.The apparatus of claim 73, wherein the tube has an out diameter of about 0.25 inches.